ENERGY STAR Connected Thermostats

Stakeholder Working Meeting
Field Savings Metric

February 26, 2016

Agenda

- Data call
  - Status: what can we conclude from the data we got? Not much
  - Proposed quick fix and resubmit data – will there be enough data after fix
- Next set of extensive software revision
  - Fix ΔT_{base} optimization in CDD/HDD methods
  - Data validity – daily data and hourly data
- Weather normalization – is it a good idea, and how easily could we do it?

Attendees

Abigail Daken, EPA

Doug Frazee, ICF International, for EPA

Jennifer Kulp, ICF International, for EPA

Dan Baldewicz, ICF International, for EPA

Alan Meier, Lawrence Berkeley National Laboratories

Ethan Goldman, VEIC

Nick Lange, VEIC

Michael Blasnik, Nest Labs

Dave Cassano, Nest Labs

Raj Shah, Carrier

Paul Kiningham, Carrier

Phil Ngo, Impact Labs

Brent Huchuck, Ecobee

Wade Ferkey, AprilAire

Jack Callahan, BPA

Michael Siemann, Weatherbug Home

Wendell Miyaji, Comverge

Laurie Sobczak, Comverge

Alex Bosenberg, NEMA

Matt Golden, Open EE

Ed Pike, Energy Solutions, for CA IOUs

Ford Garberson, Ecofactor

Ram Soma, Ecofactor

Chris Smith, IRCO (Trane)

Roy Crawford, IRCO (Trane)

Kurt Mease, Lux Products

John Sartain, Emerson

Charles Kim, SoCalEdison

Henry Liu, PG&E

Data request and proposed “quick fix”

- Three data sets received
  - Where data made sense, results were within a factor of 1.5 to 2 of each other
  - However, not enough data to answer the critical questions to move forward
- Proposed “quick fix” – protect statistics module from NaN, inf
  - Throw out thermostat-seasons with Nan, +inf or –inf results rather than trying to include in the regional summary statistics
  - Not intended to stay in software long term
  - Intended to allow resubmission of data from which some conclusions can be drawn for the purposes of the spec
  - Will that leave enough data to draw conclusions from?

Data request – results discussion

- Some where models are not at infinity but clearly bizarre.
  - Look at distribution of MSE divided by the mean and throw out outliers?
- Three different methods of calculating savings – do any of them have a greater tendency to have real results?
  - Not really able to tell
- No one volunteered whether they thought the fix would work
- Current version does not have this fix yet
- What is the current handling of inf or NaN?
  - At least the infinites are averaged in
- One stakeholder thought re-running with the fix would be easy

More extensive fixes in next software revision

- Fix ΔT_{base} optimization in CDD/HDD methods
  - Bound the optimization: 0F – 15F
  - Keep optimization we have and throw out non-physical values?
  - Michael – how did you do the optimization?
- Include goodness of fit statistics (broader range)
- Will output a single set of heating and cooling savings regardless of start and stop dates and lengths of data stream

More extensive fixes in next software revision (cont)

- Proposed data validity rules
  - 5% or more of total days in the data set are missing run time data, do not use that thermostat for summary statistics module
  - For any hourly temperature data we have (outdoor, possibly indoor), interpolate over missing single hour; if more than one consecutive hour missing, do not use that day's information
  - Summary statistics module can discard thermostats with poor fits
- Statistics module capable of calculating weighted national average savings scores. Weightings based on national share of heating/cooling energy used in each climate zone
- Python package version dependencies static

Software revisions discussion

- ΔT_{base} optimization
  - Grid search in 1F increments from 0 to 20 F
  - Where ideal value is at one side or the other are the same ones with poor fit
  - Throwing out non-physical values (0 to 20F)?
  - For a super-insulated home, 20F might not be enough
  - Depending on the way it's averaged, particularly if there are multiple thermostats in a home, 0 as a minimum might not be enough. How about -10F to 50F?
  - Does a broader range mean we will be including data from homes that would have other heating sources?
  - Seems like the best idea is to get the software basically working, then see if we've excluded enough

Software revisions discussion

- Throw out any algorithm or thermostat that has a negative slope?
  - Source of heating outside control of thermostat
  - Could two thermostats in the home do this?
- When one model gives unphysical results, do they all?
  - Can't tell yet
- Goodness of fit statistics – use two switches. Better to output several different measures of goodness of fit together or one at a time?
  - 1 vote for several together, though the fact is that any of them are better than none
- Screening out – even for homes with a poor fit, we will still have temperature data. We could use some median temp float or something to see if there is a systematic difference in thermostat behavior. Nice idea if we screen out many, requires more thought

Weather normalization discussion

- What would we get out of it?
  - Results of metric as currently set would tend to vary from one year to the next based on weather variation. [add more here]
  - Do vendors see differences in average of run times in different years? Yes, >20% easily.
  - Issue here is with poor comparability between years, not between vendors, yes?
    - Also don't want an atypical year to make it appear a product is non-compliant
    - Year to year variation could exceed likely savings from CTs – signal we are looking for would have a lot of noise

Weather normalization discussion

- How would we do it?
  - Basic method: instead of comparing actual run time to modeled baseline run time with actual weather and baseline thermostat behavior, compare modeled run time in some typical year with actual thermometer behavior to modeled run time in a typical weather year with baseline thermostat behavior.
  - Typical weather year:
    - TMYs only exist for some places
    - Could use historical average weather at station used for each thermostat
    - There is a service that can fill in weather with a 20 year average down to a 1km grid (paid)

Weather normalization discussion

- Weather normalization made more complex by split seasons (but not insurmountable)
- Two potential issues:
  - Thermostat behavior depends somewhat on weather, but probably a smaller effect that the one we are trying to correct [expand for posting]
  - If forced to use 10 or 20 year averages, using data that includes influence of thermal inertia, etc., but then calculating run times using data where day to day temp swings are averaged out and therefore there would be little effect
- Also generally hesitant to make the analysis more complex, so that it makes more sense to people in general, is more meaningful

Weather normalization discussion

- Probably we can think it more simply:
  - Two pieces of data:
    - Influence of product on thermostat behavior?
    - What is the effect of that on heating and cooling?
  - Without weather normalization, that second one is really "what was the effect on that in this particular year"
- Poll: does a weather normalized result better reflect product performance than an actual year result?
  - Yes from everyone except for…
  - One caveat: One vendor has not seen it make a big difference in relative savings, so would be skeptical of any method that did show a big difference
  - Also not clear **how much** better normalized results are

Weather normalization discussion

- One vendor saw as much as 20% change in run time from one year to another - another vendor seems to say it doesn't matter. But second vendor was talking about relative savings being not very sensitive to weather, not absolute. Absolute savings definitely see changes.
- Vendor agrees relative savings varies somewhat less, but not clear how big the influence is – dependency of results on annual weather would also wash out on a nationally averaged result
- Also mentioned that its easy to make a mistake in the implementation of weather normalization.

Next steps

- Quick fix to software
- Resubmission of data
- Draft 3 in April

Contact Information

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